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Birdsfoot Trefoil

Seed Production

By Virgil B. Hawk, field plant materials technician
Soil Conservation Service

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BIRDSFOOT TREFOIL SEED PRODUCTION

cc
by Virgil B. Hawk, field plant materials technician, Soil Conservation Service, and collaborator, Agronomy Department, Iowa State University

SUMMARY

Birdsfoot trefoil began to show promise as a useful perennial legume in the Midwest about 20 years ago. Trials in Iowa, Minnesota, Illinois, and Indiana, following earlier tests in New York, indicated its importance as a pasture and hay crop. Technicians and farmers in the Corn Belt were especially impressed with its value as a legume for seeding on renovated bluegrass pastures.

Birdsfoot trefoil maintains itself well on soils of low fertility. It is particularly adapted to wet soils or those with poorly drained subsoil. Adequate production of cover and forage can, however, be obtained only by fertilizing and liming on soils low in plant nutrients or calcium. Birdsfoot trefoil is more drought resistant than red clover but is less hardy than alfalfa. The domestic strains, as represented by the Empire variety, are particularly resistant to close grazing and winter injury. The imported strains, such as French and Italian, are less winter hardy and are better adapted for hay production. Narrowleaf trefoil and big trefoil are distinct species with limited adaptation to mild climates. These facts are supported by research and field tests in a number of States.

Birdsfoot trefoil demonstrated its value for soil-conserving cover and forage on class VI soils in the eastern two-thirds of Iowa in field plantings from 1941 to 1948. With increased interest in the legume, soil conservation district seed plots were established in Iowa from 1949 to 1953, to meet a pressing seed need.

The district seed plots were established with seed supplied by the Soil Conservation Service (SCS) to the soil conservation districts. Seed production was by district co-operators under the terms of a written agreement with the district and with the technical assistance of SCS. The final use was for conservation pasture seedings by farmers in the local district.

Experience in production of birdsfoot trefoil seed in Iowa soil conservation districts showed:

1. A need for intensive preliminary observations on the adaptation, usefulness, and production of a new plant for soil conservation at Plant Materials Centers.

2. That confirmation of this usefulness by field plantings is needed before there is general acceptance.

3. That active participation by the district governing body is essential to the development of district seed plots.

4. That qualified technical assistance in seed production must be available to growers in districts from the Soil Conservation Service.

5. That seed produced on district seed plots must be used by district co-operators for erosion-control seedings in accordance with a conservation farm plan.

6. That continuing research on pertinent problems by the agricultural experiment station will facilitate the district program.

Surveys were made of the seed production of birdsfoot trefoil from 1950 to 1958.¹ Information was obtained on acreage, seed yield, date and method of harvest, management of the seed field, and quality of the product.

Seed production reached a peak in 1954 and 1955 when more than 40,000 pounds of seed were harvested. The trend in later years has been downward for several reasons including poor seed yields per acre.

Seed yield varied considerably from year to year ranging from 40 to 80 pounds per acre. It was affected by climatic conditions, population of harmful insects, method of harvest, and experience of growers.

Fifty four districts reported some production of birdsfoot trefoil seed from 1950 to 1958. Out of the 147 farmers who attempted to produce seed, 30 experienced seed producers developed continuing seed production.

Date of harvest varied, depending on the management of the field in the spring, from July 15 to August 15. Generally, those who

¹ Surveys were made with the cooperation and assistance of the Agronomy Department, Iowa Agricultural Experiment Station.

took seed from the unpastured first-cutting had the earliest harvest and best seed yields. Pasturing until May 15 reduced vegetative growth and made seed harvest easier to accomplish.

Five methods of seed harvest were used. Windrow-combine was the most successful, but there has been a constant and large increase in the amount of direct-combine harvest. The "round bale" and "field chopper" methods never became popular. Threshing out of the stack became obsolete in the forties.

Control of destructive insects was important but was never practiced by most of the growers. Those who did use an insecticide generally had the highest seed yields. Honey bees were placed in the seed fields by about 20 percent of the growers.

Loss of stand in the seed fields from disease was a serious problem associated specifically with seed production. The stand losses occurred shortly after close mowing of rank growth of mature plants.

Purity and germination analyses were obtained by one-third of the growers. Timothy, red clover, and sweet clover were common causes of impurity. Curled dock and sheep sorrel were the most prevalent weed seeds. Some low germination from heating of uncured seed was noted. Hard seed was not a problem. Most experienced seed growers could obtain seed with a minimum purity of 98 percent with 80 percent viable seed, including not over 35 percent hard seed.

Certification was never adopted by Iowa growers of birdsfoot trefoil seed. Success of the district-seed-plot program encouraged basic research on the factors affecting birdsfoot trefoil seed production.

DISTRICT SEED PLOTS

The development of district seed plots of birdsfoot trefoil was preceded by observational studies at the SCS nurseries (now called Plant Materials Centers) and by field plantings in soil conservation districts. Thus, there was an established need when the seed plots were started in 1949. Along with the production of seed there was continuing emphasis on the use of this new legume for soil conservation by pasture renovation.

Seed produced by the SCS nurseries was obtained originally from the Preston Hollow area in New York (4).² It was reproduced



Figure 1.--Foundation-seed field at the Ames nursery, 1945.

one or two generations in Minnesota or Iowa (fig. 1). This strain, closely related to Empire, was used in all field plantings and seed plots. The domestic strain is better adapted to grazing than the imported French and Italian strains.

Soil conservation districts in Iowa had their first experience with district seed plots in the rapid increase of Fischer smooth brome. Procedure for the development of district seed plots of birdsfoot trefoil was based on experiences with smooth brome. The SCS furnished foundation seed to the districts. In turn, each district allotted the seed to three farmer-cooperators who agreed to return 25 percent of the seed crop to their district as reimbursement for the original seed and technical assistance. The returned seed was generally used to establish additional seed fields or demonstration plantings.

Most, but not all, of the seed plots were successfully established. In no case, where inoculant was supplied with the seed, was there a failure from lack of inoculation. Failures resulted from:

1. Not grazing off or mowing the oat companion crop early and closely.
2. Not applying fertilizer on soils showing a low phosphorus level.
3. Plowing up the stand without reviewing it with an experienced technician.

This last problem was probably the most frustrating part of the district seed-plot program.

Eight districts established seed plots in 1949, 13 more were seeded in 1951, and an additional 8 in 1952 (fig. 2). Out of these 29, only 5 districts failed in their attempt. To the formal district seed-plot list, other districts could be added. These include the Jones County Soil Conservation District

² Numerals in parentheses refer to Literature cited on p. 12.

where the nursery produced seed under contract with a farmer in 1947 and 1948. In at least 8 other districts, old demonstration plantings were converted to seed plots. Thus, by 1953, about one-third of the districts were actively sponsoring birdsfoot trefoil seed production.

Seed growers in other counties became interested in and began to harvest seed because of the high price and considerable local demand. This was also true, and to a greater degree, in districts where cooperators led the way on district seed plots.

SEED PRODUCTION IN DISTRICTS

As part of the technical assistance to soil conservation districts, detailed surveys were made of birdsfoot trefoil seed production on district seed plots from 1950 to 1958. The information obtained included seed produced, acreage harvested, seed yield, date and method of harvest, management of the seed field, use of pollinating insects, control of destructive insects, and the laboratory analysis of the seed.

This information has been reviewed and summarized in tables 1 and 2. Seed yield per acre is shown in figure 3 and seed production by districts in figure 4.

Annual trends

The known production of seed for the 9 years was 158,433 pounds. The greatest production was in 1954 when the best yield of seed per acre was obtained. In 1955, the largest number of growers harvested seed and the greatest number of districts reported some seed harvest.

After an optimistic start in 1950, acreage harvested and seed produced dropped considerably from 1951 to 1953. In fact the total production in these 3 years was less than that in 1950. The importation of cheap seed from Europe caused many districts and farmers to lose interest in production of domestic seed. When this problem began in 1950, field plantings were started to compare the domestic strain with the imported strain of birdsfoot trefoil. On all but one of the field plantings in 13 soil conservation districts, the domestic strain was superior to the imported strain under grazing. These observations were confirmed by research on plots clipped to simulate grazing (7). When this information was made available to district cooperators in a publication aimed primarily at them (3), interest in seed production was renewed in 1954.

Severe drought in most of Iowa drastically reduced production in 1956. The acreage



Figure 2.--Birdsfoot trefoil seed plots in soil conservation districts: Guthrie County (upper left), Tomo County (upper right), Story County (lower left), and Adair County (lower right).

TABLE 1.--Summary of birdsfoot trefoil seed production in Iowa, 1950 to 1958

	Dis- tricts	Growers	Seed produced	Acreage har- vested
	Number	Number	Pounds	Acres
1950.....	19	20	10,348	184
1951-52....	16	18	5,000	115
1953.....	16	21	4,867	95
1954.....	27	58	42,882	537
1955.....	34	66	40,062	711
1956.....	26	41	20,914	329
1957.....	23	33	12,409	322
1958.....	27	67	21,951	516
Total	54	147	158,433	2,809

harvested was only about 50 percent of that in 1955. Many fields were abandoned and some were killed. The drought was most severe in southern Iowa and adjacent Missouri. A survey showed that on 76 fields in Iowa and adjacent Missouri 12 percent were completely killed by drought, 22 percent were severely injured, another 22 percent



Figure 3.--Average yield of birdsfoot trefoil seed and percent crop harvested by direct combine.

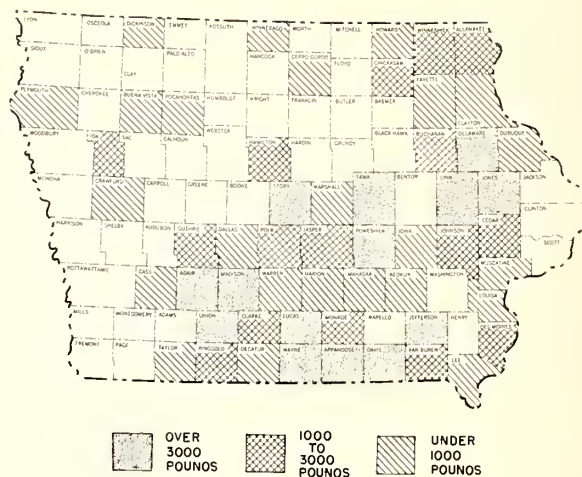


Figure 4.--Birdsfoot trefoil seed production in low soil conservation districts, 1950-58.

were injured, and 44 percent showed little or no injury.

There were several reasons for the poor production in 1957. The chief reason was the heavy infestation of lygus bugs, leafhoppers, and other destructive insects. Another reason was that seed production had begun to increase in other States and districts in Iowa were no longer vigorously promoting seed production. By 1958, national production was in excess of demand and birdsfoot trefoil seed prices dropped considerably.

Seed yield per acre

Seed yield per acre varied considerably from year to year (fig. 3). Seed yield was affected by climatic conditions, population of destructive insects, technical competence of the grower, information available on methods of seed production, and amount of technical assistance available locally.

Climatic conditions were favorable in 1950. There was a lack of interest in 1951. Climatic conditions were unfavorable in 1952. Technical assistance was curtailed in 1953. These were also the years when "know how" was limited.

In 1954, there was a combination of favorable climate, few destructive insects, experienced growers, and available technical information and assistance which resulted in maximum seed yield. High humidity at harvest time was a particularly favorable factor.

In 1955, there was an increase in the number of growers and districts producing

TABLE 2.--Percentage of growers in the several seed production, acreage, and yield levels, and percentages in the various management classes

Item reported by growers in survey	1953	1954	1955	1956	1957
	Per- cent	Per- cent	Per- cent	Per- cent	Per- cent
Percentage with production below 500 lbs.....	88	70	59	68	70
Percentage with production 500 to 1,000 lbs.....	12	14	21	20	21
Percentage with production 1001 to 2,000 lbs.....	0	7	14	10	9
Percentage with production over 2,000 lbs.....	0	9	6	2	0
Percentage harvesting less than 5 acres.....	56	48	38	41	37
Percentage harvesting 5 to 10 acres.....	38	26	29	37	27
Percentage harvesting 11 to 20 acres.....	6	19	18	17	21
Percentage harvesting over 20 acres.....	0	7	15	5	15
Percentage with seed yield over 180 lbs./a.....	0	7	6	3	3
Percentage with seed yield 120-180 lbs./a.....	0	10	8	3	0
Percentage with seed yield 60-120 lbs./a.....	38	26	21	29	18
Percentage with seed yield below 60 lbs./a.....	62	57	65	65	79
Percentage harvesting in late July.....	-	53	53	48	-
Percentage harvesting in August.....	-	35	26	36	-
Percentage harvesting in early September.....	-	0	14	8	-
Percentage with no date reported.....	-	12	7	8	-
Percentage who took first cutting for seed.....	-	30	40	78	-
Percentage who pastured in early spring.....	-	58	53	14	-
Percentage who took second cutting for seed.....	-	7	2	6	-
Percentage indefinite as to spring treatment.....	-	5	5	2	-
Percentage harvest by direct combine.....	12	25	44	58	67
Percentage harvest by windrow-combine.....	82	65	46	36	27
Percentage round bale harvest method.....	6	10	7	6	6
Percentage field chopper harvest method.....	0	0	3	0	0
Percentage using insect spray.....	6	21	12	28	10
Percentage not using insect spray.....	94	79	88	72	90
Percentage with bees in seed field.....	6	12	18	19	21
Percentage without bees, except native.....	94	88	82	81	79
Percentage reporting purity and germination.....	-	33	32	19	24
Percentage not reporting tests.....	-	67	68	81	76
Percentage of growers reporting ¹	-	74	86	88	94

¹ All growers reported total seed production and acreage harvested. Other data obtained by letter survey, except in 1953 when growers were contacted personally.

seed. Most of the new growers were inexperienced and lost much of the seed crop from shattering.

It was noted that capable seed producers often far exceeded the State average. Inexperienced growers often had seed yields of less than 40 pounds per acre. In most years, 60 pounds of seed per acre should be the expected minimum. As shown in table 2, about one-third of the growers produced more than 60 pounds per acre. More than 100 pounds per acre are normally expected by experienced growers.

In 1956, the drought did not reduce seed yields on the acres harvested. In fact, it appeared that dry weather favored seed

yields if the vegetative growth were adequate.

In 1957, destructive insects caused poor seed yields. Growers who sprayed got good seed yields, but only three used insect-control practices.

The large increase in percentage of the crop combined direct may have accounted for some of the decrease in seed yields from 1954 to 1958.

Number of districts and growers

The largest number of districts reporting seed production was 34 in 1955. The

largest number of growers in any one year was 67 in 1958. The total number of districts and growers listed in table 1 are cumulative totals of new districts and growers as reported each year.

In 1955, it was found that of the 108 farmers who had harvested seed since 1950 only 5 growers had produced seed for 3 consecutive years--1953 to 1955. In 1956, out of the 123 known growers, only 10 had produced seed for 3 consecutive years. However, by 1957 there were 30 experienced growers in the State, most of them in the Tama County Soil Conservation District.

As the years went by, new districts and new growers tried their hands at seed production. By 1958, about 147 growers in 54 counties had at least attempted to harvest seed. The distribution of the production is shown in figure 4. Production was concentrated in southeast Iowa, the area of greatest need, high humidity, and pioneer plantings. Birdsfoot trefoil is not adapted to the droughty, permeable soils of western Iowa. In addition, seed production is hazardous in areas with low relative humidity at harvest.

Date of harvest

The surveys of individual growers indicated that there were two periods of seed harvest. Those who did not pasture their fields, but took seed from the first-cutting, harvested their fields in late July. Those who pastured their fields during May had mature seed in early August. Date of harvest varied somewhat from year to year, ranging between July 15 and August 15, with a few second-cutting seed harvests in late August and early September.

Ways of handling of the first-cutting varied considerably. Research data (2) have indicated that clipping or taking a hay crop from the first cutting reduces seed yields. However, clipping is not the same as grazing; the dates of clipping were begun fairly late; and there was no control of destructive insects.

Pasturing the mixture of birdsfoot trefoil and Kentucky bluegrass from late April until May 15 reduces competition from the vernal-dominant grass and reduces the bulk of trefoil straw at time of harvest (fig. 5). If the grazing animals are removed by May 15 and destructive insects controlled by



Figure 5.--Birdsfoot trefoil seed field after being pastured from late April to May 15. Early spring grazing reduced the volume of vegetative growth at seed harvest but not the seed yields.

insecticides, satisfactory seed yields can be obtained.

The percentage of the growers who pastured their fields in early spring decreased considerably from 1954 to 1956 (table 2). Generally those who took seed from the first cutting obtained the better seed yields. However, many reported difficulty in handling the large bulk of straw in threshing.

Method of harvest

Five methods of seed harvest were attempted with birdsfoot trefoil; only two were widely accepted. Percentages of the seed crop harvested by four methods are shown in table 2.

The standard method of harvest has been to mow the trefoil when most of the pods are in the light brown stage (fig. 6). A short, 5-foot mower bar powered by a four-wheel tractor is preferred (fig. 7). A center-delivery windrower is used (fig. 8). A C-shaped bar is attached to the mower divider point to facilitate cutting and dividing the mowed swath. The material is allowed to dry in the windrow from 12 to 24 hours. It is then threshed by a combine-thresher with a pickup attachment. This method is still used by experienced seed producers. Experiences with seed harvest on district seed plots confirm the statement by McPherron (4) that combining from the windrow is the most successful method of harvest.

Direct-combine harvest method has increased rapidly in popularity because of the anticipated reduction in time and labor. This method of harvest has some problems because the leaves and stems of birdsfoot are green at seed maturity. Also, the time of blooming is indeterminate and several stages of seed-pod maturity may be present.

The direct-combine method was pioneered in Iowa by a grower in the Lucas County Soil Conservation District on a $2\frac{1}{4}$ -acre field in 1947. His seed yields ranged from 75 to 258 pounds per acre from 1947 to 1950. A considerable part of the seed came through the combine as unthreshed pods. It was necessary to dry these before rethreshing. The secret of his success was the small size of the field.

Desiccants have been suggested as an aid to direct combining (9). Growers who tried them in 1956 to 1958 lost most of their crop by shattering.



Figure 6.--Birdsfoot trefoil produces flowers and seed pods at the same time. Experience is required to determine when most of the pods are ready to harvest.

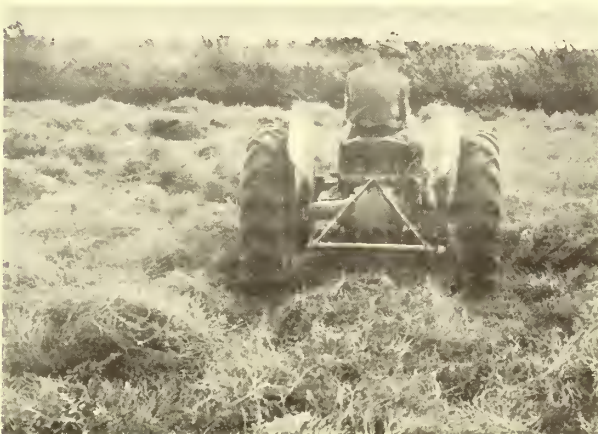


Figure 7.--Mowing birdsfoot trefoil with a short bar mower equipped with a center-delivery windrower. After a drying period the windrow is picked up and threshed with a combine. This is the most satisfactory method of seed harvest under humid conditions.

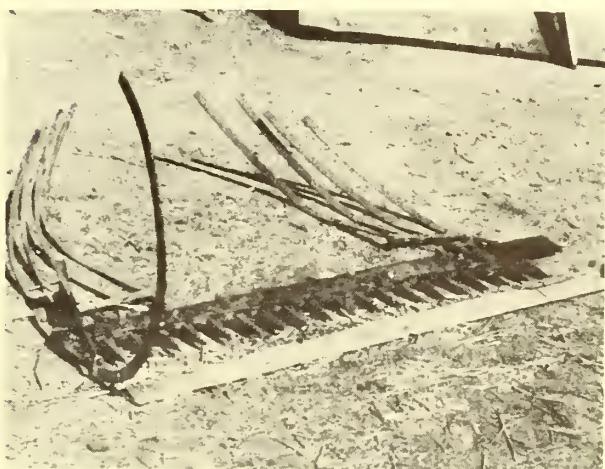


Figure 8.--Center-delivery windrower on a 5-foot mower bar with a C-shaped divider which had been the most satisfactory for birdsfoot trefoil seed harvest.

In the early days of seed production (1943-47) there was some stacking of the semicured material followed by threshing from the stack with a stationary threshing machine. This was abandoned because of the labor involved and excessive seed loss (4). A later adaptation was barn-drying the mowed trefoil followed by threshing after it was dry.

A few farmers tried the "round-bale method" each year from 1953 to 1957 but abandoned it because of the labor involved. In the "round bale method," the crop is mowed at the light brown stage of pod maturity. It is then windrowed and baled in a round bale before drying to avoid shattering. After curing in the loosely bound bale, the material is threshed. However, one grower in the Madison County Soil Conservation District obtained about 200 pounds of clean seed per acre on a 30-acre field in 1954 with this method. If the material is baled too green or too tightly, it will heat and destroy germination. The bales must be split with a power saw. A stationary thresher with a large capacity is required for the threshing.

The SCS nursery tried the field chopper in 1952. It was impossible to adequately dry the green chopped straw, and heating resulted. Seed yield was low, and germination of the seed was reduced. Farmers who used the field chopper for seed harvest lost their crop.

Insect and disease control

The SCS nursery began cooperative studies with the Extension entomologist for the control of lygus bugs and other destructive insects on a district seed plot in the Guthrie County Soil Conservation District in 1951. The results were encouraging, and in 1952 some detailed trials were set up on the SCS nursery seed field near Van Meter (fig. 9). Spraying with toxaphene increased the seed yield from 93 to 164 pounds per acre. Therefore, technical recommendations from 1953 forward included the latest information on insect control. However, the percentage of growers who sprayed to control insects never exceeded 30 percent.

In 1957, when only three growers used spray, lygus bugs substantially reduced seed yields. The same was true in 1955. Those who did use an insecticide generally had the highest seed yields in the district and in the State.



Figure 9.--Spray equipment used at the SCS nursery seed field near Van Meter, Iowa. Spraying about tripled the yield of seed.

Along with the control of destructive insects, placement of bees in fields exceeding 5 acres was recommended. Since, after 1953, the average size of the seed fields was 10 acres, most growers could advantageously have used bees but only about 20 percent did.

The most serious disease has been a crown or root rot. This disease is much more severe when the plants are allowed to grow to maturity and then cut for hay or seed. It does not seem to be as serious on closely grazed pastures.

Several fields died out after seed harvest, and the loss was much more severe during a drought. It was especially serious in 1956 when it was difficult to separate disease and drought effects. When seed fields did die out after harvest, the stand was often renewed by volunteer from shattered seed.

Purity and germination tests

Although all growers were encouraged to take seed samples and obtain analyses, the number who did so was never more than 33 percent.

Mixtures of other crop seed were fairly common. Timothy was the "other crop" which often reduced the percentage of pure trefoil seed. Kentucky bluegrass was never a problem. Red clover and sweetclover were difficult to remove from trefoil, but white clover could generally be separated. Growers of birdsfoot trefoil seed should avoid any mixture of timothy or red clover in the field (fig. 10).

Horse nettle is common in trefoil fields in southern Iowa, but no seed of this noxious weed was found in any trefoil seed. In the analyses reviewed, no other primary noxious



Figure 10.--A mixture of timothy with birdsfoot trefoil on a seed field in the Jones County Soil Conservation District. Timothy was the most difficult seed to remove from trefoil seed.

weeds were found. Curled dock and sheep sorrel were the most common secondary noxious weed seeds in the samples.

Some growers had low germination, probably from heating of uncured seed in storage. Direct combine harvest requires careful drying of the seed. Hard seed was not a problem, as many persons believe. Most experienced growers could obtain seed with a minimum of 98 percent purity and total germination of 80 percent, with not over 35 percent hard seed.

Certification was not available to birdsfoot trefoil seed growers during the early years of the district seed-plot program. When certification was made available, the growers were reluctant to enter into the program.

RESEARCH

The successful district seed program and the demand for seed for conservation plantings encouraged research at the Iowa Agricultural Experiment Station. Much of the research was concerned with the use of this new legume for pasture and hay. Several studies directly related to seed production were published from 1955 to 1957. This

research has application to the Corn Belt and other areas with similar continental climate.

Anderson (1) studied the development of pods and seeds as related to maturity and seed yields. He developed a system of estimating the proper date of harvest based on changes in seed-pod color. Seeds were morphologically mature 27 days after bloom when the pods were a light brown color. He concluded that higher seed yields may be obtained if harvested when a majority of the pods are light green to light brown in color. Anderson and Metcalfe (2) confirmed that the best yields of trefoil seed are obtained when the legume is grown in combination with Kentucky bluegrass. Late spring and early summer clipping reduced seed yields in comparison to the unclipped check. Early clipping reduced seed yields less than later clippings. The earliest date of clipping tested was May 20, and there was no control of destructive insects. They did not measure the effect of early spring grazing but did observe that grazing did not reduce seed yields as drastically as did mowing.

Metcalfe *et al.* (5) showed that there is a critical relation between relative humidity and seed-pod shattering. They found that shattering occurs at relative humidities between 30 and 35 percent. There was a close interdependence of relative humidity, moisture equilibrium, and pod splitting. They concluded that seed production would be favored in geographical areas with relative humidity above 40 percent at harvest. Any attempt to select for shattering resistance should be done under known conditions of relative humidity and moisture equilibrium.

Peacock and Wilsie (6) reported on the possibilities of selection for resistance to seed shattering. This is one of the more serious problems of seed production, and selection of nonshattering strains may be the only solution. Through one cycle of selection, shattering was reduced 17 percent. Additional cycles of recurrent selection will be required to reduce shattering to a satisfactory level.

Scholl and Staniforth (8) found that herbicides can be used to control weeds in the establishment of birdsfoot trefoil. TCA and Dalapon gave almost complete control of grassy weeds with little or no injury to the legume. A combination of 4 pounds of Dalapon and 1/2 pound of 4 (2,4-DB) controlled both grassy and broadleaved weeds. Companion crops of small grain reduced stands and yields of birdsfoot trefoil under all managements studied.

Wiggans, et al. (9) reported that the use of desiccant sprays in harvesting seed increased the speed and ease of direct combining. The chemicals tested did not affect seed viability or plant stand. While they stated that the use of desiccants in seed production appeared promising, they noted that pod-moisture content was reduced, which could increase shattering losses. Endothal, DNBP, and PCP were the most effective desiccants tested.

Unpublished data by Wilsie³ indicated that "Iowa Empire" was superior to "New York Empire" in forage yield and stand survival. Natural selection has been a powerful force in changing the local adaptation of birdsfoot trefoil. This confirms observations made on field plantings and district seed plots. At the SCS Plant Materials Center, seed from the pasture strain grown in the Corn Belt for three or more generations produced more vigorous seedlings than certified seed of Empire from New York (fig. 11).



Figure 11.--Relative seedling vigor of strains M2-11348 and M2-11366 or the Elsberry SCS Plant Materials Center 6 weeks after emergence. Both originated from naturalized stands in New York. M2-11348 had been reproduced for three generations in Iowa, and M2-11366 was New York certified seed.

³ Wilsie, C. P. Natural Selection and Performance of Birdsfoot Trefoil. Forage Seed Panel; Div. 10., Amer. Soc. Agron. Meetings. 1958.

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